Homemade Copper Solar Cells

Selenium was extensively used in the production of commercial solar cells before silicon. Although it can be a somewhat difficult to find a supplier and it is a toxic heavy metal, it is relatively inexpensive and can often be found in old model radio sets, where it was used in the rectifier of the power supply. A selenium photocell is made from a metal plate (usually iron) with one side being covered with a layer of selenium. A very thin layer of silver or gold is spattered over the selenium layer forming a layer of current-carrying material that allows light to pass through it. This layer is called a transparent electrode. A metal electrode called a collector, rests on the gold or silver near the edge of it.

Wires are attached to the collector and the iron plate to deliver the electric current to the load. Although not as great an output as more modern cells, a selenium photocell can produce as much as eight milliamperes for each square inch of surface area exposed to bright sunlight.

Cadmium sulfide is probably the most promising low-cost solar cell second only to silicon.

If you have an interest in electronics, you will undoubtedly recognize cadmium sulfide (the common "CDS" cell) as the material used in light detecting circuits. Although inventors have realized for some time that a number of materials such as cadmium sulfide change their electrical resistance in the presence of light, it has only been in fairly recent times that it was realized they could also be used to generate power also.

The most important attribute of cadmium sulfide is that it could be mass-produced efficiently using a thin-film procedure wherein very thin layers of its photosensitive components are evaporated onto a base metal or screen printed.

Cadmium cells are fairly efficient (3-5 typical) making them a good rival for amorphous silicon cells.

An Experimental Cell With Cuprous Oxide

The best cell by far for the you to start with, is a cell made with cuprous oxide (Cu^O). Copper actually has two oxides, a red

oxide called cuprous oxide, and a black oxide called cupric oxide (CuO).

The dark red cuprous oxide has photoelectric properties but black cupric oxide does not. The black oxide that forms on the outside of your cell must be removed because it is opaque and will not allow light to reach the cell's active surface.

Building your solar Cell

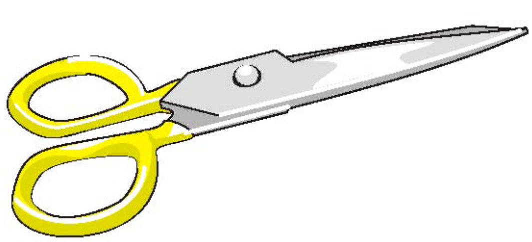
Step 1. Cut a piece sheet copper into the size and shape you wish for your cell. Although .025 inch thick copper was used for the cells described here, just about any thickness will do.

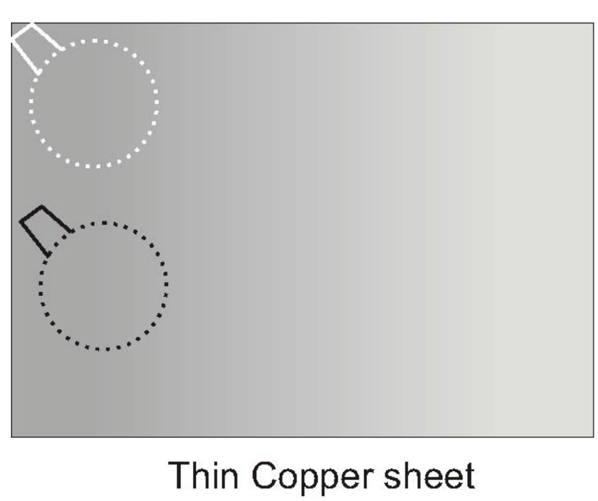
Copper is a soft metal and can be cut with tin snips or even with an old pair of scissors.

Cut your cell with a diameter of 1 1/2 inches, we strart with a smaller cell because it is much easier to work with. The larger the heat source the bigger the size copper you can use to create your solar cell. After you get the hang of it you can then build larger cells..

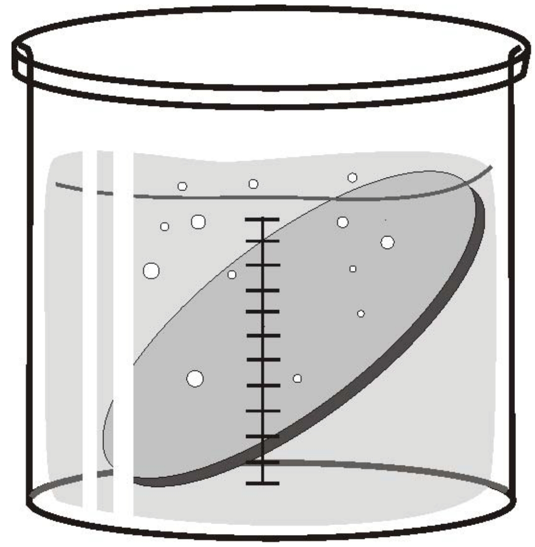
As you cut the copper, be sure to leave a "handle" so that you may grip the cell with pliers without marring the cell's active surface.

Thin Copper sheet





Step 2. the surface of the cell must be made extremely clean. Prepare a solution of nitric acid by carefully mixing 20 parts nitric acid and 80 parts distilled water. Remember towear protective goggles or other suitable eye protection and to work in a well ventilated area whenever you work with chemicals.



Copper disk, scoured & polished and dipped in acid.

IMPORTANT! ALWAYS ADD ACID TO WATER! NEVER ADD WATER TO ACID!

Begin by carefully polishing the face of the cell with a fine grade of steel wool until it shines brightly. Then place the cell with the shiny side up, in the solution of nitric acid.

Soon, tiny bubbles will form on the copper disk. Stir the solution occasionally. When the disk seems shiny and well cleaned, remove and rinse it under cool running water.

WARNING! Never to allow your skin to touch the acid, and that no acid remains on the cell.

The cell will sometimes work without the acid cleaning if it is simply well polished by the steel wool. However, we strongly recommend the acid cleaning.

Nitric acid and the other chemicals mentioned in the text can be easily ordered from a number of mail-order chemical houses such as found in the classified section of magazines such as Popular Science.

Step 3. Cuprous oxide is now formed on the disk by heating it over a Bunsen burner, or propane torch. A gas stove can be used, but results may be unpredictable.

The time me disk must be heated varies greatly depending on the heat of the torch, and the thickness and size of the copper piece. Using a standard propane torch from the hardware store and a disk of the described size, I found 2 minutes and 40 seconds to be ideal. If you heat it too long, you run the risk of burning off the oxides. Heating for too short a time may prevent the oxides from forming fully.

Copper disk, scoured & polished and dipped in acid.

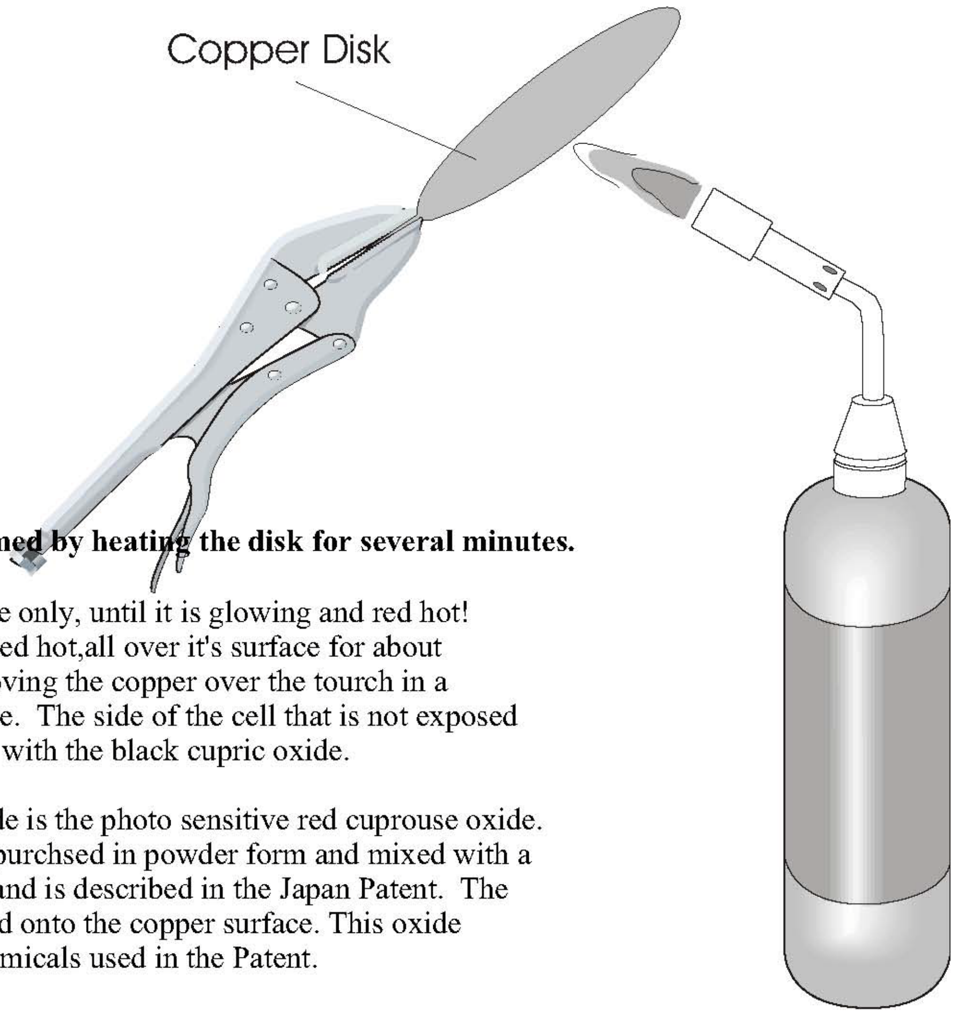


Photo sensitive oxides are formed by heating the disk for several minutes.

The Copper is heated on one side only, until it is glowing and red hot! copper must be kept at an even red hot,all over it's surface for about 2 minutes and 45 seconds by moving the copper over the tourch in a round motion. counter clock wise. The side of the cell that is not exposed to the flame will become coated with the black cupric oxide.

Now just beneath this black oxide is the photo sensitive red cuprouse oxide. This red cuprouse oxide can be purchsed in powder form and mixed with a special solvent, which is clear, and is described in the Japan Patent. The Oxide can then be screen printed onto the copper surface. This oxide material is different than the chemicals used in the Patent.

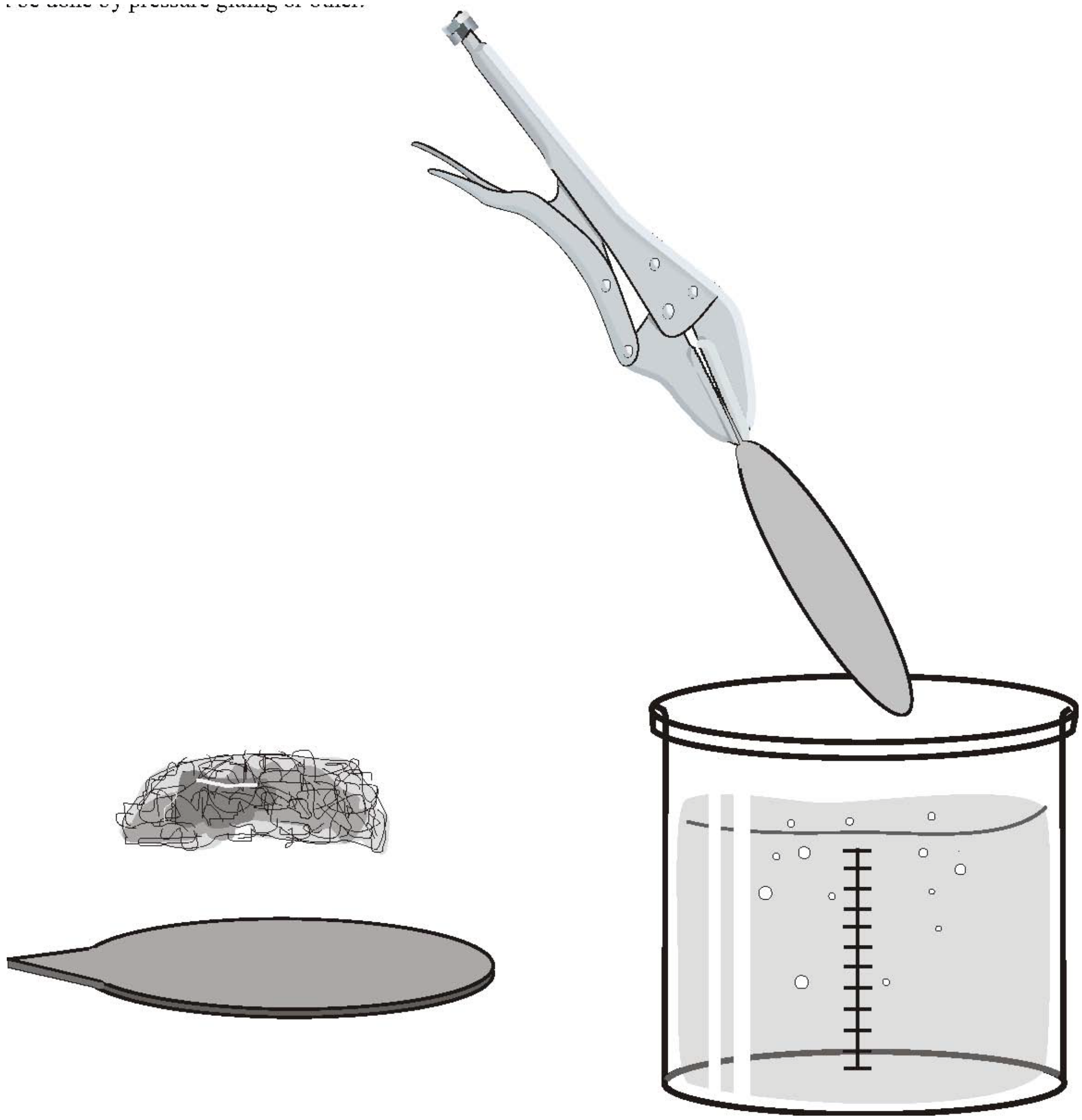
After heating your cell for the prescribed time, it must be carefully cooled. There are two ways to go about this. You can cool the copper quickly by either placing it face down on a flat metal surface, or by waiting a few moments and then quenching it in cool water. The advantage to cooling the cell quickly is that the unwanted black cupric oxide will often flake off the cell due to the difference in contraction rates of the oxides. Unfortunately, I have had bad luck with this method despite extensive experimentation with different temperatures and procedures.

What has worked very well for me is to bring the cell's temperature down as slowly as possible making sure the black oxide does not crack at all. Once completely cool, the cell is immersed in the nitric acid bath. You must wait while the acid begins to dissolve the black oxide. Then you remove and rinse the cell.

A very weak solution of sodium cyanide can also be used with good results. However, you should be extremely careful when using it. Cyanide is an extremely poisonous chemical, and if accidentally mixed with an acid can create deadly fumes. At this point the black oxide covering the cell can be rubbed away with steel wool and a little elbow grease. After all of the Black oxide has been removed, your cell should have a uniform caoting of deep red on one side.

black oxide has been removed, your cell should have a uniform coating of deep red on one side. Don't worry if the very outside edges of your cell don't have the coating, this is due to uneven cooling and is normal. Keep in mind that the red coating must not be scratched or scraped away to reveal the bare copper plate beneath. If this happens the cell might short in the final step and not work at all.

Testing: There are now several ways that you can test you solar cell even though it is not finished, it can generate power. If you are building the cell for a science fair or other demonstration, you may want to stop and use the cell at this point while the cuprous oxide is still visible. If you hold the cell near a source of bright light, a current will



be generated between the cuprous oxide coating and the copper plate. The copper will form the positive terminal and the cuprous oxide the negative.

Making contact with the copper portion of the disk is very easy. Simply sand a small bare spot on the back of the solar cell and attach a wire. Attaching the wire and making a good contact with the cuprous oxide is more difficult, it is hard to solder and attach anything. but it can be done by pressure gluing or other.

method of making a good contact with this large of a surface area, is by attaching a wire grid to it. A better way is to apply a very thin layer of silver or gold called a transparent An easily fabricated but temporary transparent electrode can be made from salt water. Or as seen in our Chlorine cells and a container glued to the cell and the liquid applied. A soloution of salt or acid will conduct electricity and also pass light to the cell. Drip a small amount of salt water or your spit, on to the center of the cell. Make sure that the water rests only on the cuprous oxide and does not touch any of the solar cell's copper surface or it will short out and will not produce any free electrical energy at all.

Now, attach one wire from a galvanometer, digital voltmeter using the milliamp or low voltage setting to some exposed portion of the cell's copper surface. Usually the back or the edges have some exposed copper. Touch the other meter lead to the surface of the water. The meter will spring to life. Next, bring a bright source of light such as a 100 watt bulb near the cell. The meter should show a slightly smaller voltage as the light approaches. Your cell will produce best in sunlight! The cell is changing some of the light into electricity but is having to counteract the current generated by the saltwater, hence the drop in voltage. The salt water actually acts as an electrolyte and with the oxide generates its own current just as a small battery would. Another way that you can test your cell is by making a wire electrode for the surface. This is done simply by coiling some 30 gauge silver-plated wire or aluminum wire and by holding it against the (cells) cuprous oxide surface with a sheet of glass. A good way is to coil the wire around is to use a cone shaped dowel or other object first in order to make good even spirals. Make sure that the wire touches the cuprous oxide only, and none of the bare copper. You will always have some bare copper around the edges of the cell, so it is best to paint with enamel paint, let dry and then work with the cell.

By simply attaching one wire of your meter to the silver wire, and one to the cell's exposed copper, you will be able to register a small current when a light is brought near. In this form, the cell can be operated indefinitely and makes an excellent Science Fair Display.

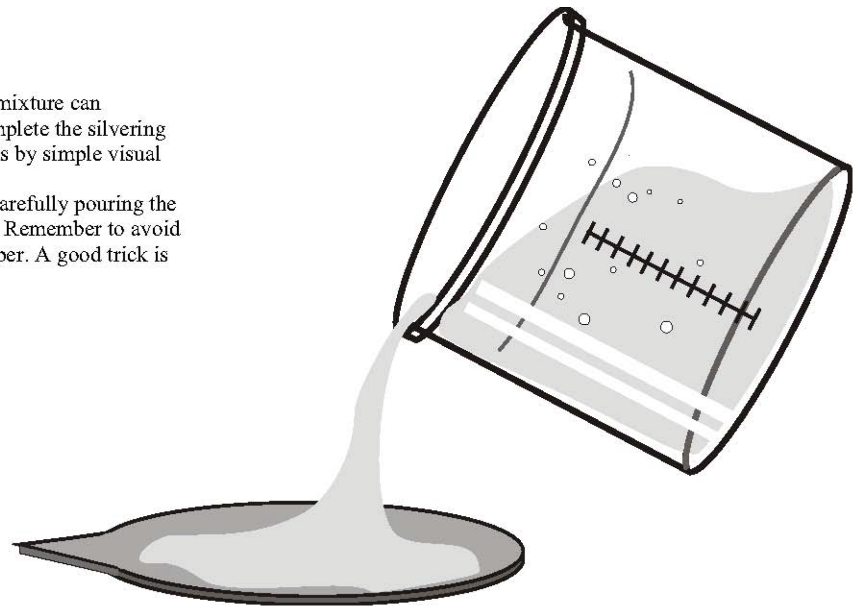
Making The Silvering Solution: The final step in making your own solar cell will be to make a permanent transparent electrode. When properly applied, this will give your cell a beautiful semi-mirrored finish and allow you to make electrical contact with the whole cuprous oxide face of the cell. This step is probably the trickiest in the production of the cell.

But, just as with the last steps, it becomes somewhat easier with practice. Using distilled water, make ten percent solutions each of ammonia water, potassium hydroxide and potassium sodium tartrate in seperate test tubes. A ten percent solution can be created by mixing 10 parts by weight of solute in 90 parts of water. Please remember that the test tubes can become warm or even hot when the water is first added, so be sure to use Pyrex glass test tubes. Also, make certain you have ample ventilation when mixing the ammonia solution. Dissolve in 1 oz. water a single crystal of silver nitrate. The crystal should be somewhat larger than the head of a match. Begin adding drops of the ammonia solution to the dissolved silver nitrate until the water first becomes brown, and then just begins to clear. Add a drop of potassium hydroxide to this solution. Then again begin adding drops of ammonia water until the solution just begins to clear. The solution will remain somewhat cloudy. Too much ammonia in the solution can

Applying The Solution

Temperature and variations in the chemical mixture can dramatically change the time required to complete the silvering process. The best way to complete this step is by simple visual examination of the process as it proceeds.

With the cell on a flat surface, begin by carefully pouring the silvering mixture on to the center of the cell. Remember to avoid letting this mixture contact any exposed copper. A good trick is



dissolve the cuprous oxide coating and can damage or ruin the cell. Stir the mixture while adding a single drop of the potassium sodium tartrate solution. The mixture is now ready and should be used immediately.

Applying The Solution

Temperature and variations in the chemical mixture can

to cover with paint or lacquer any exposed copper surfaces on the face of the cell. Continue pouring until the liquid has covered as much of the surface as you can . If all the exposed copper on the surface has been properly protected with the lacquer, you can actually pour the solution until it comes right to the edge. Since water has an affinity for itself
called "cohesion", it won't spill over the edge. Very soon, a thin film of silver will begin to form over the cell's surface. The liquid should be poured off when the red oxide is still slightly visible beneath the silver. allow the silvering process to go a little too long rather than not long enough since some of the silver coating can be polished away.You should now have a smooth silver coating through which the red oxide is barely visible.

Completing the Cell contact can now be made to the cuprous oxide face of the ell by means of a ring of lead or silver-coated wire which is slightly smaller in diameter than the disk itself. With the ring held firmly against the disk, a protective coating of thin lacquer can be applied. Make certain the lacquer does not come between the wire and the disk. With wires attached to the disk's copper back and the lead or silver ring, the cell is complete. The disk can now be housed behind glass, mounted to a sheet of plastic, cast in a clear resin or housed in any other enclosure you desire!